Direct diagnostics concept for high power CO_2 laser at the LPP focus spot

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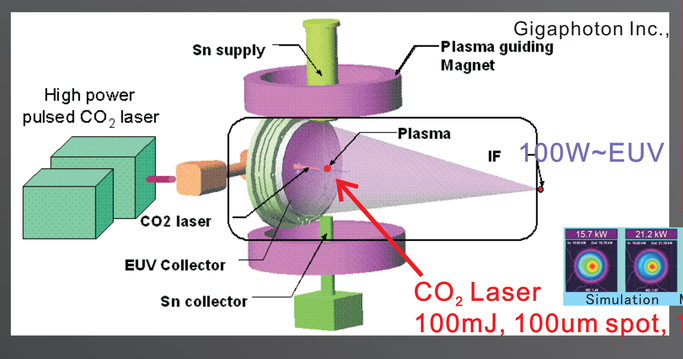
Abstract

In the Laser Produced Plasma (LPP) EUV source, stability of CO_2 laser, which produces plasma, is the most important issue. The required CO_2 laser exceeds more than 100kHz repetition 200mJ pulse with 100micron spot and 1ns pulse duration at the plasma point. Direct diagnostics of such a high power pulse cannot be achieved by the recent technologies. Position, energy, and timing stabilities are neccessary for stable EUV source, moreover, the ideal laser spot profile is also needed for higher conversion efficiency (CE). This presentation proposes the unique diagnostics for such high power laser pulses at the focus point. This technique based on laser-Compton scattering with a very small spot electron beam. Focused electron beam, of about 10micron size, is scanned over the laser spot as the SEM, the laser-Compton scattering photon has the information of the high power laser pulses. If we scanned the electron beam from various direction, the laser focus profile can be obtained like a CT image. We believe that this technique can provide the valuable information for stabilizing and optimizing the EUV source. The concept of this diagnostics, simulation studies of focused scanning electron beam, and future plans will be presented at the conference.

LPP Source

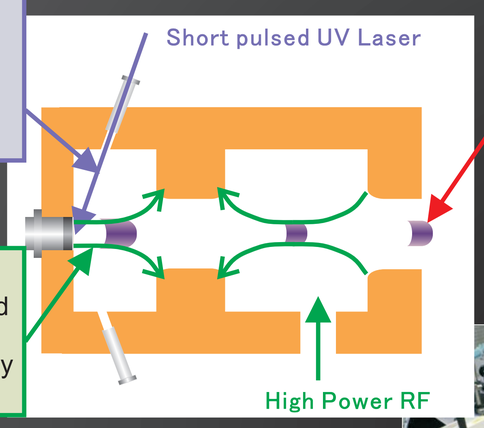


High power CO_2 laser diagnosis
>Measure and optimize real spot
>Perfect compensation thermal effect
>Spot feedback will available (non-destructive)

Direct observation by
"Laser-Compton scattering"
by scanning electron beam
"SEB Compton Diagnosis"

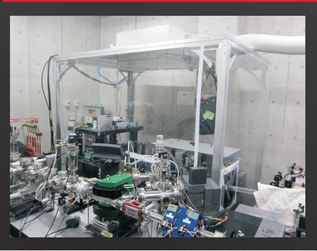
Photocathode rf electron gun

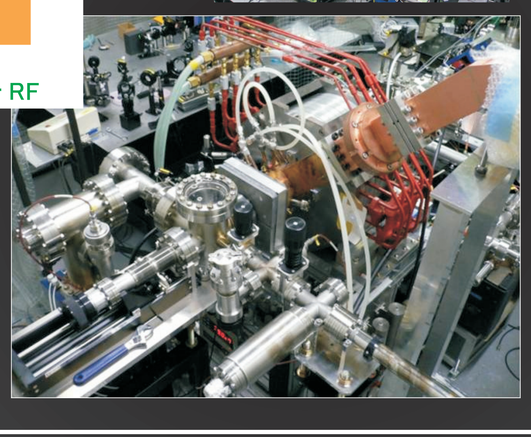
Short pulsed UV laser produces short pulsed electron bunch
Time structure of electron can be controlled by laser



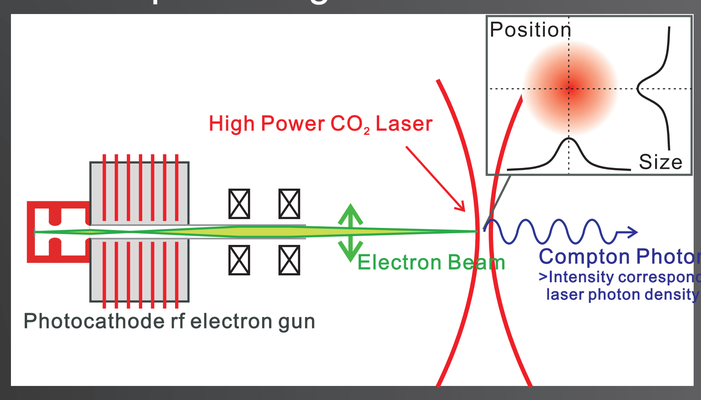
More than 100MV/m electric Field on photocathode accelerate immediately
>High quality

High quality electron beam with high current (dose), good directivity, more than 5MeV energy, and short pulsed





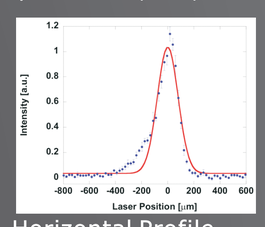
SEB Compton Diagnosis



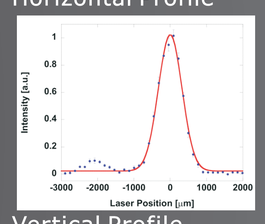
Laser Size>EB Size
Laser Spot Measurement
If we can observe various direction profile,
2D or 3D laser profile can measured by CT technique

Design study of very small spot electron beam generation by photocathode rf electron gun

Laser Size<EB Size
EB Spot Measurement
K. Sakaue et al.,
Rad. Phys. Chem. 77(2008)1136



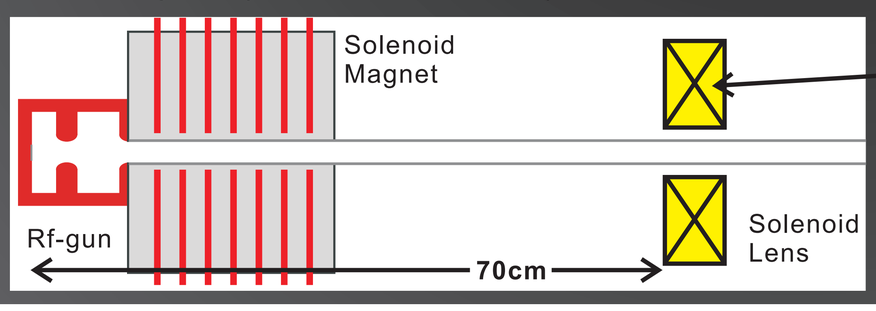
Horizontal Profile

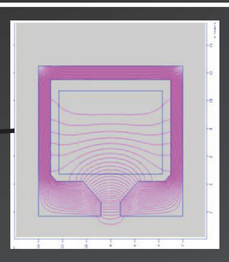


Vertical Profile

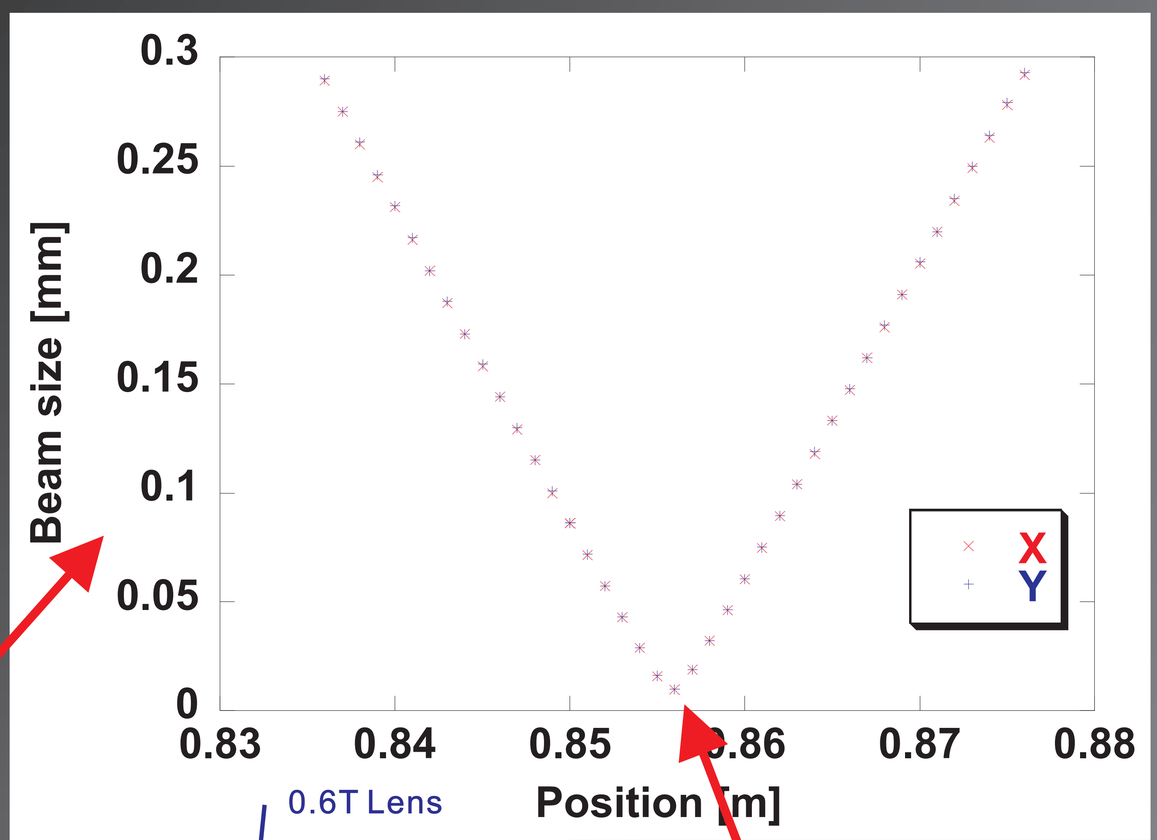
Small spot electron beam generation study for SEB Compton diagnosis

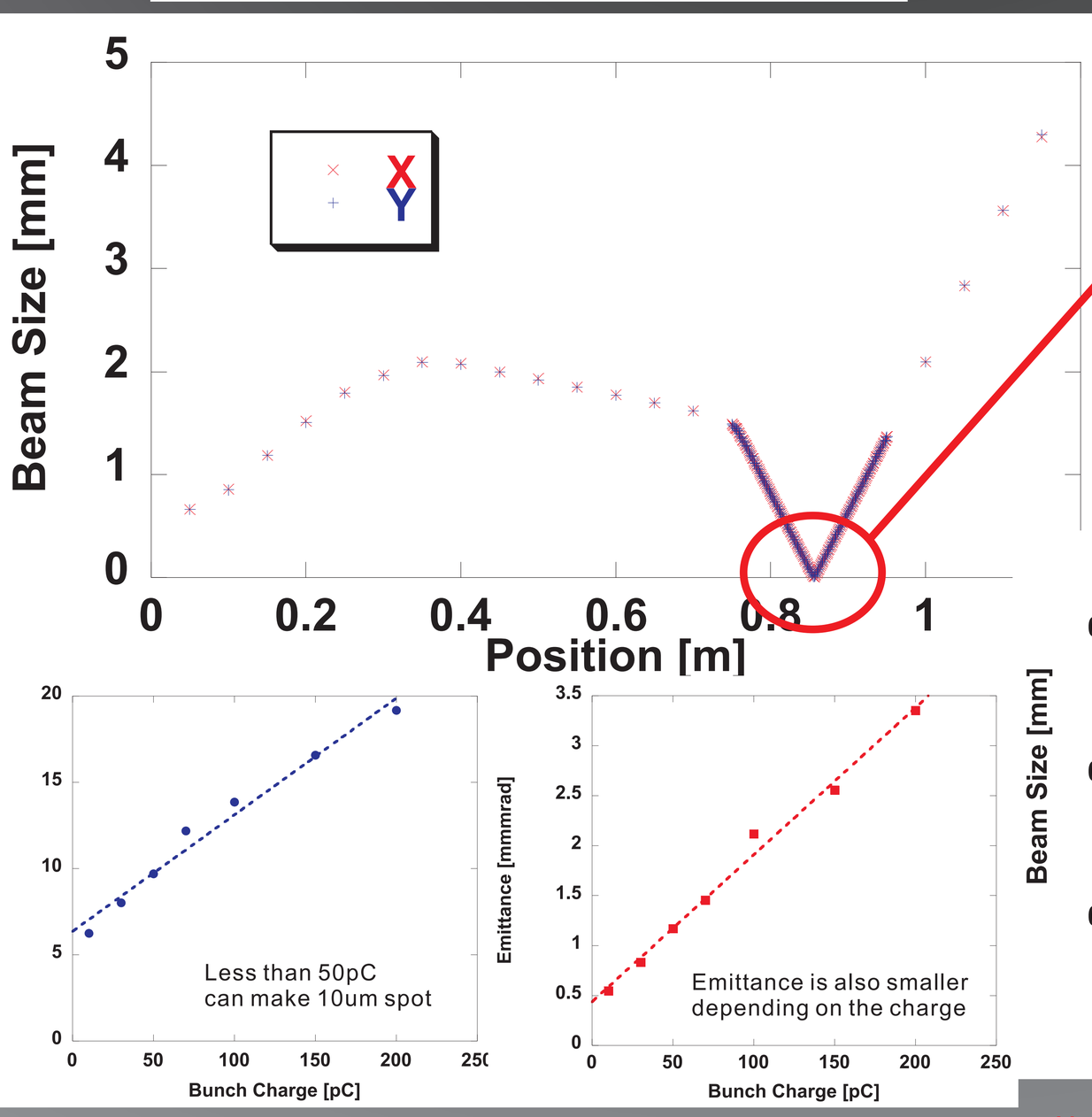
Electron beam simulation by GPT (General Particle Tracer)





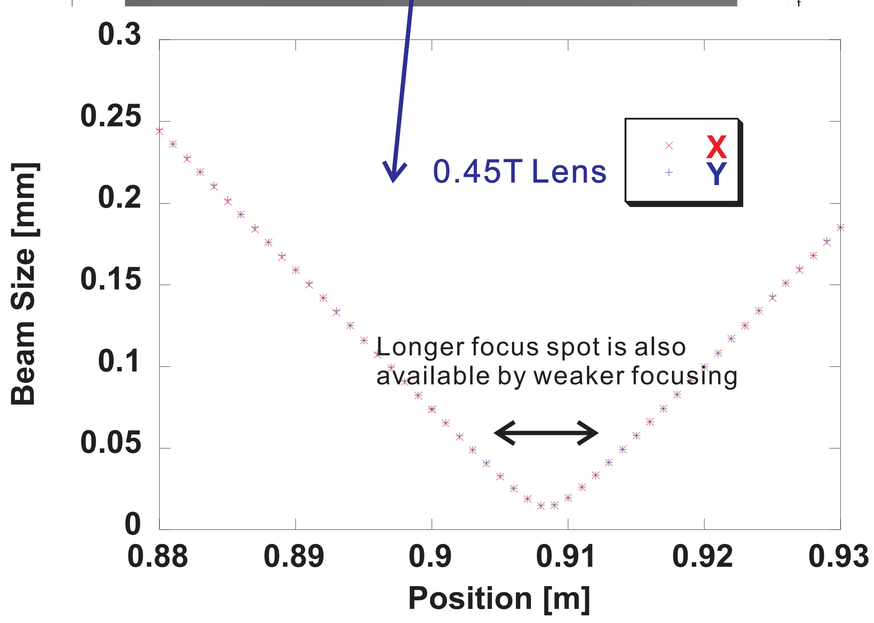
Lens shape optimized by Poisson

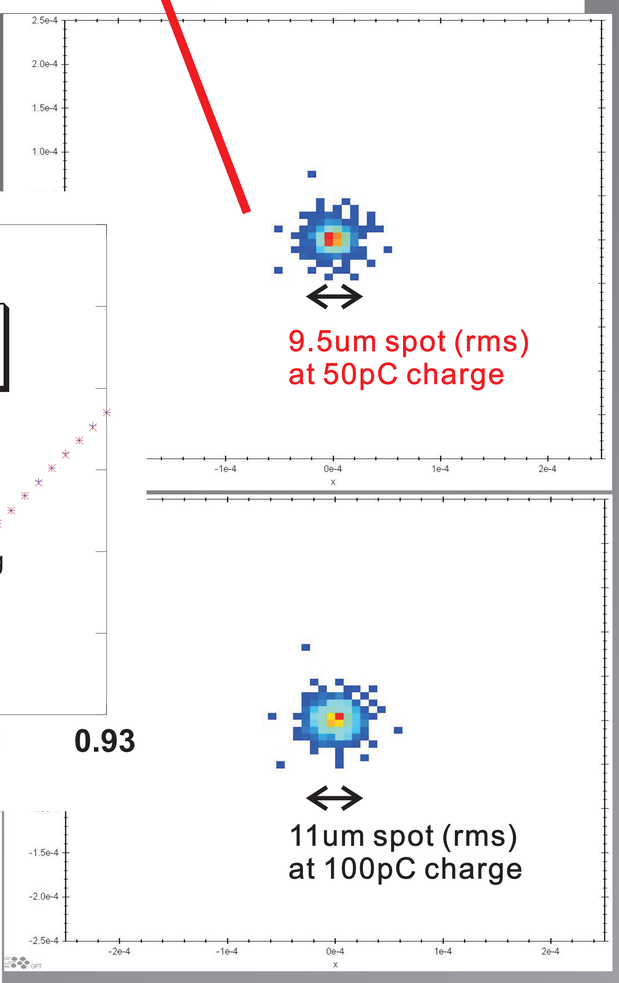




0.6T Lens

0.45T Lens





Summary and future prospects

LPP EUV source needs small and stable spot at the interaction point with Sn droplet.

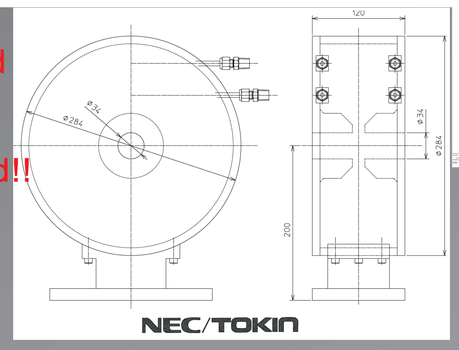
New diagnostic technique is proposed;
Scanning electron beam can visualize the high power laser spot by laser-Compton scattering.
Using CT technique, real focus profile can be obtained.

Design studies are performed at Waseda University,
less than 10um (9.5um : 50pC) / around 10um (11um : 100pC) can be achieved by our photocathode rf electron gun with the magnet lens.

Lens is already designed and ordered, we will performed the SEB Compton technique in near future.

Newly designed Solenoid Lens

Already ordered!!
Coming soon!!



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